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The occurrence of *Eimeriinae* Wenyon in the hare in Poland

Występowanie *Eimeriinae* Wenyon u zajęcy w Polsce

During the investigations carried out in Poland in 1958 — 1960, the present authoress confirmed the etiological factor in the hare coccidiosis being the following species of *Coccidia*: 1) *Eimeria leporis* Nieschulz 1923, 2) *Eimeria townsendi*, Pellérdy 1956, 3) *Eimeria robertsoni* Carvalho 1943, 4) *Eimeria europaea* Pellérdy 1956, 5) *Eimeria hungarica* Pellérdy 1956, 6) *Eimeria semisculpta* Madsen 1938, 7) *Eimeria stefanskii* sp. n.

The endogenous development of all of the above coccidians is going on in the epithelial cells of the intestine. The parasites forming the *Coccidia* fauna in the hare were established by methods of dissection (totally 223 dissections were carried out), oöcyst cultures in vitro and, finally, on the ground of 463 coproscopic examinations utilizing the flotation techniques with saturated NaCl solution.

The immature *Coccidia* oöcysts occurring in the hare have many characteristic features resembling those occurring in the rabbit (*Eimeria leporis* excepted). That is why a close tracing back of sporulation and of its duration is necessary in order to define the particular species.

Up to present day, many authors continue to consider *Coccidia* of the hare and those of the rabbit as specifically identic (Yakimoff, Polnek-tov et Rastagaieff 1931) while Lucas, Laroche et Durand 1959 in their study seem not to take into consideration the significant specificity characteristic of *Coccidia*. Yet, it results from studies recently carried out that the rabbit's *Coccidia* do not occur in the hare.

On the other hand, however, Carvalho 1943 carried out cross infections with both the rabbit's and the hare's *Coccidia* and arrived at the conclusion that *Eimeria* sp. sp. are closely specific of *Leporidae* in the great majority of cases. These conclusions were corroborated and worked out in detail by Pellérdy 1956 who has examined 200 hares in this respect since 1954.

However, the present authoress' own close examinations of oöcysts cultivated in formalin and potassium bichlorate, and her observations on the oöcysts' sporulation as well enabled her to show the problem of the *Coccidia* specificity being not a merely theoretical one. The above thesis was corroborated by the steadily negative results obtained following attempts at

rabbit infestation with the hare *Coccidia* oöcysts. Thus, for instance, the hare invasive oöcysts belonging to species *Eimeria leporis* caused no invasion when introduced into rabbits (as established by the negative results of the coproscopic examinations).

The problem of the occurrence of the hepatic species *Eimeria stiedae* in the hare still remains unresolved according to Pellérdy 1956. The specificity of *Eimeria stiedae* is not as close as that of other intestinal *Eimeria* sp. sp. according to the author mentioned. However, the author does not describe any invasion of this species in the hares in Hungary in contrast to other investigators as described such invasion (Henry 1931, Reichenow 1952, Erhardová et coll. 1953, Nevenić, Šibalić, Cvetković 1954, Lucas, Laroche, Durand 1959) in other countries.

Still, the results of the above investigations should be considered with much reservation as the investigations were limited to the coproscopic examinations only on most occasions, and the results obtained were corroborated neither by the dissectional nor the biological (sporulation) observations.

The results of the present authoress' investigation of that problem are not in agreement with the observations of the authors mentioned above. Indeed, absence of *E. stiedae* invasion was confirmed in 200 dissected hares originating from different regions of Poland; neither were discovered any pathological changes in the epithelial cells of the hepatic biliary ducts as would be demonstrative of the presence of these *Coccidia*.

Table I

Comparison of the *Eimeria* species found

Species	Measurement of oocysts in microns		Shape of oocysts	Colour	Micropyle	Residual bodies		Sporulation time in days
	from - to	average				in the oocyst	in the spores	
<i>E. europaea</i>	25-30.5 × 15-20	30 × 17	ellipsoidal, or fusiform, tapering at both ends	grey yellow	good visible	+	-	3-4
<i>E. hungarica</i>	12-15 × 11-14	14 × 13	almost round	colourless	absent	+	-	2-3
<i>E. leporis</i>	26-38 × 13-22	32 × 16	oblong-cylindrical	colourless	absent	+	+	2-3
<i>E. robertsoni</i>	34-52 × 22-35	40 × 25	ovoid to ellipsoidal	yellowish-brown	good visible	+	+	3-4
<i>E. semisculpta</i>	34-45 × 22-27	39.9 × 25.7	cylindrical-ellipsoidal	yellowish-brown	good visible	-	+	3-4
<i>E. townsendi</i>	37-54.5 × 25-39	43 × 31	ovoid	yellowish-brown	good visible	-	+	weeks

Seven species of *Coccidia* parasitize the hare in Poland (see Table I). A comparison of the qualitative indices of the invasion extent of *Coccidia* in the annual cycle is shown in Table II.

Table II
Occurrence of the Eimeria species in the hare in Poland

Month and year	Number of hares examined	E. europaea		E. hungarica		E. leporis		E. robertsoni		E. semisculpta		E. townsendi		E. stefanski sp.n.		Totally	
		number	%	number	%	number	%	number	%	number	%	number	%	number	%	number	%
XII.1958	20	4	20	2	10	12	60	2	10	3	15	11	55	0	0	16	80
I.1959	51	4	8	0	0	12	24	2	4	5	10	13	25	0	0	18	35
II.1959	31	1	3	1	3	7	23	0	0	2	6	10	32	0	0	13	42
III.1959	8	0	0	1	12	2	25	0	0	1	12	2	25	0	0	4	50
IV.1959	41	8	20	0	0	15	37	0	0	3	7	14	34	0	0	24	59
V.1959	37	4	11	0	0	14	38	2	5	1	3	10	27	0	0	22	59
VI.1959	26	5	19	4	15	12	46	3	12	2	8	15	58	0	0	21	81
VII.1959	23	4	17	1	4	13	57	3	13	3	13	9	39	0	0	23	100
VIII.1959	29	6	21	0	0	14	48	5	17	5	17	14	48	0	0	24	83
IX.1959	21	4	19	3	14	8	38	3	14	3	14	7	33	0	0	13	62
XI.1959	41	6	15	0	0	10	24	2	5	2	5	14	34	0	0	23	56
XII.1959	59	1	2	3	5	11	20	0	0	1	2	14	24	0	0	28	47
I.1960	44	9	20	3	9	15	34	5	11	9	20	10	23	3	9	32	73
II.1960	31	5	16	4	18	4	18	3	10	7	23	7	23	0	0	22	71

Description of the material collected

Eimeria leporis Nieschulz 1923

Hosts: *Leporidae*, particularly: *Lepus europaeus* Pallas, *Lepus timidus* L., *Sylvilagus mearnsi* Allen.

Location: small intestine.

Geographical distribution: Europe, North America.

Description of the parasite: slightly bent oöcysts, markedly contracted, sometimes almost cylindrical, colourless, with thin walls; absence of micropyle. Oöcyst dimensions: 26 to $38\ \mu \times 13$ to $22\ \mu$; $32 \times 16\ \mu$ on the average. According to other authors, already quoted, the medium dimensions of this species oöcysts are: 38.0 to $20.0\ \mu \times 22.0$ to $13.0\ \mu$, $30.6 \times 15.3\ \mu$ on the average.

The characteristic feature distinguishing the *Eimeria leporis* oöcysts from those of other hare *Coccidia* species is, besides the lack of the micropyle, their oblong shape. The sporulation, at a temperature of approximately 20°C , lasts for 2 or 3 days. Four ovoid sporocysts form inside the maturing oöcyst; a large residual body, spherical in shape, occurs between the sporocysts. A residual body consisting of several grains occurs in the sporocysts themselves too. Consequently, the *E. leporis* oöcysts differ markedly from those of the rabbit species known to science.

Eimeria leporis is the most widely spread *Coccidia* species occurring in the hare in Poland, and is absolutely specific of that animal only.

Eimeria townsendi Pellérdy 1956

Synonyms: *Eimeria magna* Pérard 1925 pro parte, *Eimeria magna* forma *townsendi* Carvalho 1943 pro parte.

Hosts: *Leporidae*, particularly: *Lepus townsendi campanius* Hollister, *Lepus europaeus* Pallas, *Lepus timidus* L.

Location: small intestine.

Geographical distribution: Europe, North America.

Description of the parasite: ovoid oöcysts, yellowish-brown in colour (resembling very much *Eimeria magna* oöcysts), dimensions 37 to $54.5\ \mu \times 25.0$ to $39.6\ \mu$; $43\ \mu \times 31\ \mu$ on the average. *Eimeria townsendi* oöcysts belong to the largest ones occurring in the hare. They measure 37 to $44\ \mu \times 25$ to $31\ \mu$; $40\ \mu \times 28\ \mu$ on the average, according to Pellérdy 1956. The oöcyst's envelope consists of two layers. The darker, external layer bursts along its equator during the few-day's stay of the oöcysts in potassium bichromate or in formalin, and easily slides off the inner layer.

At a temperature of approximately 20°C , duration of sporulation is considerably longer than in *Eimeria magna*, and can last as long as 14 days or even more. In the material examined, hardly 50 per cent. of oöcysts belonging to this species completed sporulation 20 days after immersion into potassium bichromate. Four oblong, spindle-shaped sporocysts form inside the maturing oöcyst; they measure $18\ \mu \times 10\ \mu$ and contain a distinct granular residual body. Mature oöcysts have no external residual body which fact constitutes one of the features distinguishing *Eimeria townsendi* from *Eimeria magna*. Disregarding these conspicuous differences, many authors had classified this species as identical with *E. magna*. So for instance, Carvalho

1943 had described it under the denomination of *E. magna* forma *townsendi*. However, the Carvalho's 1943 attempts at infesting tame rabbits with the parasitic material from hares failed which doubtlessly was suggestive of the form „*townsendi*” being specific of the hare. Yet, the author had recognized *E. magna* f. *townsendi* solely as a biological form of species *E. magna* as he did not see any morphotic differences between the latter and the former.

It was not until 1956 that Pellérdy has created a new species *E. townsendi* on the grounds of the morphologic and biologic characters mentioned above.

Eimeria semisculpta Madsen 1938

Synonyms: *Eimeria irresidua* forma *campanius* Carvalho 1943, *Eimeria magna* var. *robertsoni* forma *semisculpta* Madsen 1938 pro parte.

Hosts: *Leporidae*, particularly: *Lepus townsendi* *campanius* Hollister; *Lepus europaeus* Pallas.

Location: small intestine.

Description of the parasite: dimensions of oöcysts (resembling in shape those of *Eimeria irresidua*) — 35 to $45\ \mu \times 22$ to $27\ \mu$; $39.9\ \mu \times 25.7\ \mu$ on the average. Average dimensions of this species cysts according to Pellérdy — $38\ \mu \times 25\ \mu$. The cylindrically ellipsoid oöcysts are sometimes rather elongated resembling a failing drop. The oöcysts wall is uniform in thickness, yellowish-brown in colour. Distinctly visible micropyle. Distinctly visible granular structures in the external envelope around the micropylar pole, still better visible in oöcysts kept in potassium bichromate. Duration of sporulation at room temperature (20°C) — 3 to 4 days. Elongated sporocysts, $18\ \mu \times 9\ \mu$, form inside the maturing oöcysts. No residual body present in the oöcyst while a large granular body may be seen in the sporocysts alongside of the two sporozoites.

In examining the material collected from *Lepus arcticus groenlandicus* Rhoads, Madsen 1938 described oöcysts with granular walls denominating them *Eimeria magna* var. *robertsoni* forma *semisculpta*. He failed to notice the difference between their structure and that of the *E. magna* oöcysts and erroneously recognized them solely as a form.

Carvalho 1943 too has described this species in *Lepus townsendi campanius* under the name of *Eimeria irresidua* forma *campanius*. However, as the attempt at transferring it into tame rabbits had failed, it ought to be regarded as a particular species (Pellérdy 1956).

Eimeria robertsoni Carvalho 1943

Synonyms: *Eimeria perforans* var. *groenlandica* Madsen 1938, *Eimeria magna* forma *townsendi* Carvalho 1943 pro parte.

Hosts: *Leporidae*, particularly: *Lepus townsendi* *campanius* Hollister, *Lepus europaeus* Pallas, *Lepus arcticus groenlandicus* Rhoads.

Geographical distribution: Europe, North America.

Description of the parasite: oöcysts ovoid or nearly spherical in shape (resembling those of *Eimeria magna*), yellowish-brown in colour, measuring 34 to $52\ \mu \times 22$ to $35\ \mu$; $40\ \mu \times 25\ \mu$ on the average. According to Pellérdy 1956 they measure 34 to $48\ \mu \times 22$ to $32\ \mu$; $32.55\ \mu \times 22.26\ \mu$

on the average. According to Carvalho 1942 — 35.7 to $46.8 \mu \times 22.8$ to 32.8μ while Becker 1956 gives the following dimensions — 34.0 to $52.0 \mu \times 23.0$ to 32.0μ . Distinctly visible large micropyle approximately 8.5μ in diameter. A marked protuberance of the oöcysts wall forms a ring around the micropyle edge. Duration of sporulation at room temperature — 3 or 4 days. Four elongated sporocysts, 19μ in length on the average, with one sharp end each form inside the maturing oöcyst. A hardly visible interior residual body (in the sporocysts) consisting of a few grains only contained in mature oöcysts. A very large external residual body (in the oöcyst), 12 to 45μ in diameter.

Eimeria hungarica Pellérdy 1956

Synonyms: *Eimeria exigua* Yakimoff 1934 pro parte, *Eimeria exigua* var. *septentrionalis* Madsen 1938 pro parte, *Eimeria minima* Carvalho 1934 pro parte.

Hosts: *Leporidae*, particularly: *Lepus europaeus* Pallas.

Location: small intestine.

Geographical distribution: Europe.

Description of the parasite: small oöcysts, measuring 12 to $15 \mu \times 11$ to 14μ . These dimensions lie within the measurement range reported by other authors (e. g. by Pellérdy 1956 — 13 to $15 \mu \times 12$ to 14μ). Thin oöcyst walls colourless, almost spherical in shape. No micropyle. Duration of sporulation at room temperature — 2 to 3 days. Sporocysts occupy almost entirely the inside of mature oöcysts. No interior residual bodies while a small external residual body, composed of a few grains only, may be distinctly seen between the sporocysts in the oöcyst.

Eimeria europaea Pellérdy 1956

Hosts: *Leporidae*, particularly: *Lepus europaeus* Pallas.

Location: small intestine.

Geographical distribution: Europe.

Description of the parasite: mostly elongated ovoid oöcysts, sometimes spindle-shaped, becoming markedly narrower at both ends. Thin oöcyst wall except for the characteristic protuberance around the micropyle forming sort of folds distinctly showing the micropylar opening, 6 to 9μ in diameter. Oöcysts grayish-yellow in colour, measuring 25 to $38.5 \mu \times 15$ to 20μ ; $30 \mu \times 17 \mu$ on the average (according to Pellérdy 1956 they measure $32 \mu \times 18 \mu$ on the average). Duration of sporulation at a temperature of 20°C , in water or in 2 per cent. formalin solution — 3 or 4 days. Four sporocysts, spindle-shaped, $9 \mu \times 6 \mu$, form inside the maturing oöcyst. A distinctly visible granulated external residual body may be seen between the sporocysts while there are no internal residual bodies.

Eimeria stefanskii sp. n.

Host: *Lepus europaeus* Pallas.

Location: small intestine.

Geographical distribution: Poland.

Description of the parasite: small oöcysts, resembling those of *Eimeria europaea*, ellipsoid or ovoid in shape, often with narrow ends. Large range

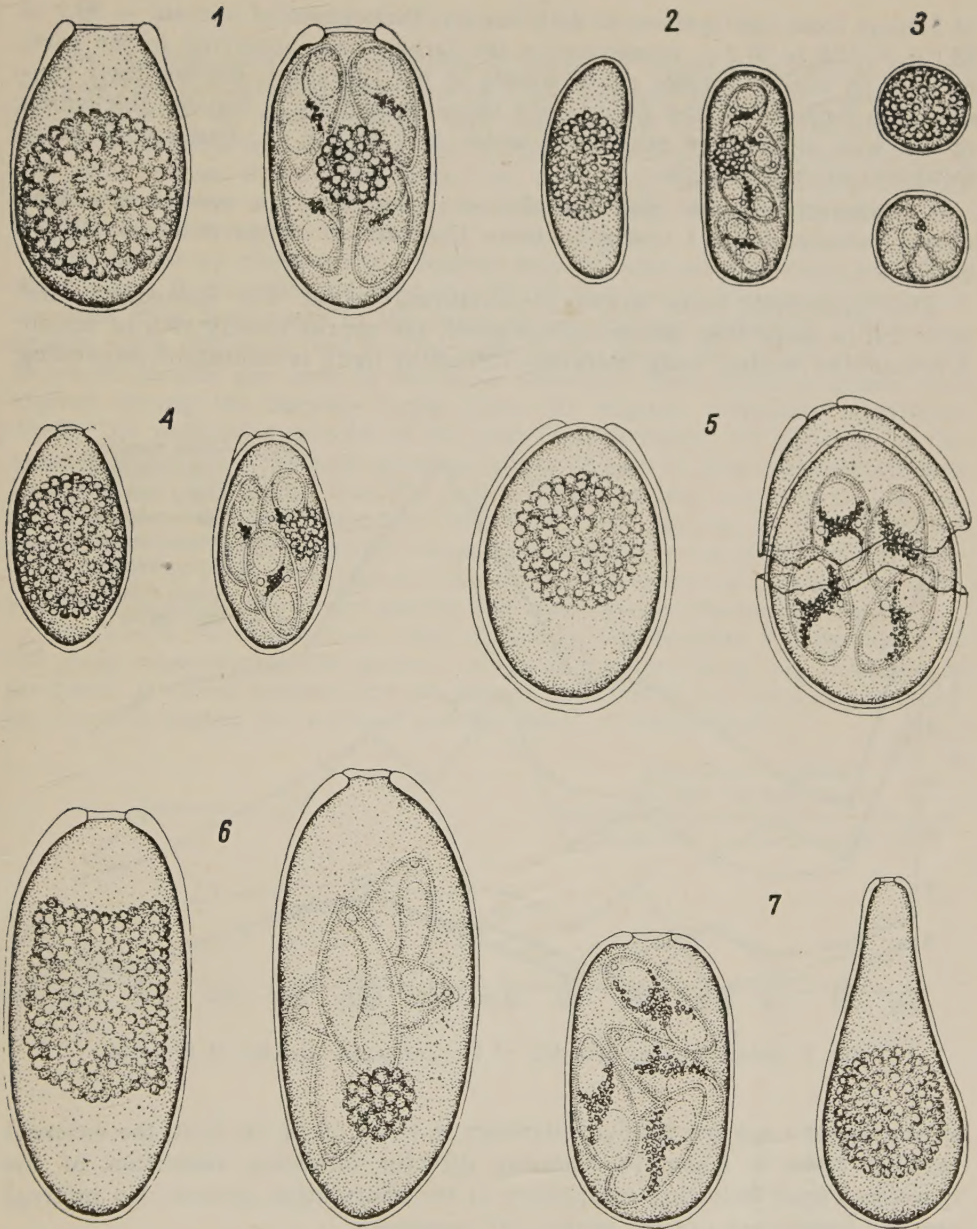


Fig. 1. The oöcysts of particular *Eimeria* species from hare:

1 — *E. robertsoni* Carv., 2 — *E. leporis* Niesch., 3 — *E. hungarica* Pell., 4 — *E. europaea* Pell., 5 — *E. townsendi* Pell., 6 — *E. stefanskii* sp. n., 7 — *E. semisculpta* Mads.

of colours from light yellow to dark brown. Dimensions of oöcysts — 59.2 to 68.1 μ $\times$ 32.5 to 37.2 μ ; consequently, the largest ones occurring in the hare; no data on similar oöcysts are available in the literature. Besides their considerable dimensions, the oöcysts are characterized by a distinct thickening of the wall around the micropyle, which is 7 to 9 μ in diameter. Slightly flattened micropylar pole.

Considerably longer duration of sporulation than in species described above, namely: from 4 weeks to more than six in temperature of 20° to 25°C.

Four sporocysts form within the maturing oöcyst. The sporocysts, first spherical in shape then becoming elongated, are approximately 15 μ in length. A granulated residual body, markedly refracting light, is inconstant, depending

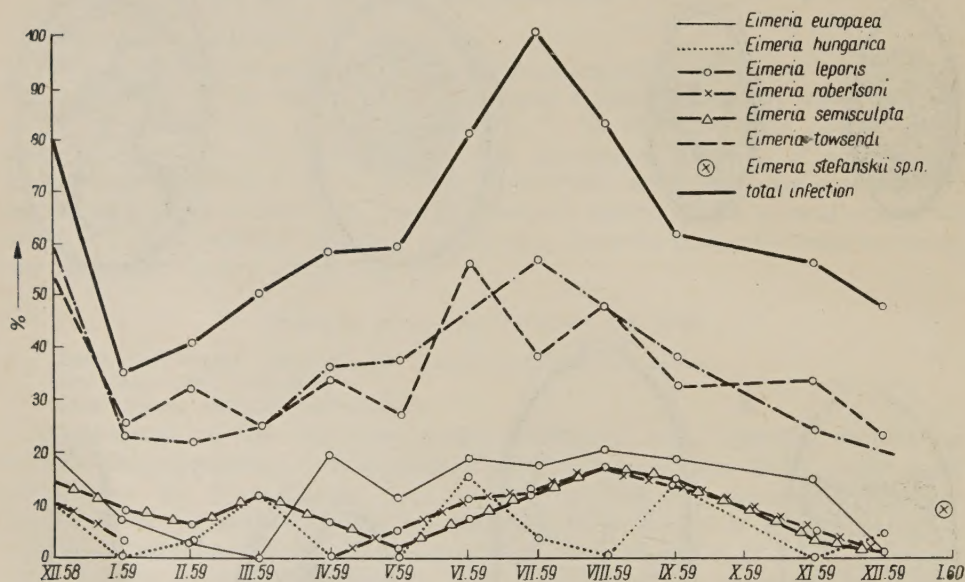


Fig. 2. Extensivity of invasion of the particular species of *Eimeria*

on the oöcyst's age (its medium diameter is about 16 μ). At first, the external residual body is wider in diameter directly following formation of the sporocysts than following completion of the sporulation process. No internal residual bodies are present within the sporocysts.

The present authoress confirmed the invasion of the species described above in three hares (No. 692, 717, 718) caught in January 1960.

The specific name, *E. stefanskii*, is given to honour Prof. Dr. Witold Stefański.

Variability of invasions

The 387 coproscopic examinations of faeces of hares from central Poland were carried out between December 1958 and January 1960. It was established on grounds of the data obtained that the invasion extent of the particular species of *Eimeria* was such as given in Table II (graphically plotted in Fig. 2). The new species *Eimeria stefanskii* sp. n. having been discovered by the present authoress not earlier than in January 1960, the data concerned are not yet included neither in Table II nor in Fig. 2.

The mixed up character of invasion may be seen clearly when analysing the figures. It may also be seen that *E. leporis* and *E. townsendi* invasions occurred most frequently in the hares on the territory examined. These two species were obviously the leading ones being found the whole year round in a considerable per cent. of the hares dissected. Their invasion extent was highest during the summer (from June till August) remaining significant during the remaining months of the year (approximately 30 per cent. of the animals examined). The high invasion extent of both of these species observed in December 1958 shows that the peak of invasion may occur at any season depending on the local climatic conditions. This applies to the remaining species too. The latter, however, occur in considerably less significant number of hares in the central regions of Poland, and the extent of invasion by these species diminishes markedly during the cold season (December—April).

The above conclusions are very distinctly corroborated by the curve of the graph representing the general extent of the *Eimeria* sp. sp. invasions in the hares. It shows further that the largest numbers of the hares are invaded by *Coccidia* during the summer months (May — September).

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STRESZCZENIE

Autorka dokonała 223 sekcji oraz zbadała łąk 465 zajęcy pochodzących z różnych okolic Polski i stwierdziła u nich zarażenie siedmioma gatunkami ziarniaków z rodzaju *Eimeria*, a mianowicie: *Eimeria leporis*, *E. townsendi*, *E. robertsoni*, *E. europaea*, *E. hungarica*, *E. semisculpta* oraz *Eimeria stefanskii* sp. n. — p. tabela I. Badania nad częstotliwością zarażenia wykazały szczególnie wielką ekstensywność inwazji *Eimeria leporis* i *E. townsendi*, oraz znaczny wzrost ekstensywności inwazji tych dwu, jak również i pozostałych gatunków rodzaju *Eimeria* w miesiącach letnich — od maja do września.